Fermilab Directorate

# MEMORANDUM OF UNDERSTANDING
# FOR THE 2005-2006 MESON TEST BEAM PROGRAM

## T955

## The RPC Detector Group

November 3, 2005

INTRODUCTION

This is a memorandum of understanding between the Fermi National Accelerator Laboratory and experimenters from Argonne National Laboratory (HEP) and Iowa University who have committed to participate in beam tests to be carried out during the 2005-2006 MTBF program. The memorandum is intended solely for the purpose of providing a budget estimate and a work allocation for Fermilab, the funding agencies and the participating institutions. It reflects an arrangement that currently is satisfactory to the parties; however, it is recognized and anticipated that changing circumstances of the evolving research program will necessitate revisions. The parties agree to negotiate amendments to this memorandum which will reflect such required adjustments.

The tests involve a set of Resistive Plate Chambers which have been built at Argonne in the context of developing Particle Flow Algorithm Calorimetry for the ILC. The purpose of the tests is to confirm the performance of RPCs with respect to the occupancy and hit rates to be expected in tests of prototype calorimeter modules in particle beams. The tests will start in fall 2005 and should be regarded as a precursor to the larger tests planned by the CALICE collaboration and the American Linear Collider Calorimetry groups.

The research on Resistive Plate Chambers for hadron calorimetry initiated at Argonne several years ago. The work has been funded by DOE through strategic LDRD grants. The detailed goals of this small scale beam test are listed below. Details concerning the design and properties of Resistive Plate Chambers, including the various pad readout schemes, can be found in Appendix I.

Winter,

## I. PERSONNEL AND INSTITUTIONS:

Spokesman and physicist in charge of beam tests: David Underwood, Argonne National Lab.

Fermilab liaison: Erik Ramberg

The group members at present and others interested in the testbeam are:

1.1 Argonne: Gary Drake, José Repond, Lei Xia, Steve Kuhlmann, Steve Magill, Barry Wicklund,

Other commitments:
CDF: S. Kuhlmann, A.B. Wicklund
ZEUS: J. Repond
STAR: D. Underwood
ILC: All

1.2 University of Iowa: Ed Norbeck, Yasar Onel

## II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The experiment is to take place in the MTEST beam line, and the MT6enclosure. The experimenters' first choice for location in the enclosure is MT6-B3 on the existing motion table, downstream of the T950 straw-tube test. Our second choice is in MT6-A2 on the upstream half of the CMS table. Our preliminary running for debugging could be done downstream of the beam stop in MT6-C if there is adequate rate of muons per unit area (see beam request) . In addition, the main control room to the west of the MTEST line will be used to house electronics .

2.1.2 We will need one 19 inch rack for electronics in the beam area, room for a Camac crate and NIM bin in the control room and space for more camac modules in an existing beam signal crate.

2.1.3 Additional work space will be needed in the control room, equivalent to at most two 6'x3' tables. This space will be used for computing and general work space.

2.1.4 We propose to put our tanks of pre-mixed gas near the racks in the gas distribution area. The house with the gas bottles could be inappropriate because the gas lines cross several feet between buildings, and in the winter weather some components of our gas mixture could condense.

2.2 BEAM

2.2.1 BEAM TYPES

The tests will use slow resonantly-extracted, Main Injector proton beam focused onto the MTest target. We will need muons, Pion beams and probably Electron beams. We list a series of requirements, roughly in order of priority and sequence of running:

A) Muons with no more than 2% electrons, and no more than 10% pions for our debugging and efficiency measurements. We will need rates down to 10-50 Hz total over a 5 inch square. Presumably this request could be obtained by inserting the MT6 secondary beam stop. Setup with our first of 3 readout methods could require 3 to 4 weeks, and we would want to have priority in utilizing the test beam for one week of this time. Setup and debugging of the other readout methods could initially be downstream of the final beam stop in MT6C.

B) Pion beam: First at a low energy such as 4 GeV and a range of intensity from roughly 10-50 Hz. Momentum spread should be less than +- 20%. Part of this running would be with material in front of the RPC to develop hadron showers and part of the running without material. Total time would be one week with the first readout system, with control over the beam for roughly half this time. Additionally, a few days for each of the other two readout methods is required at a later time. Cherenkov signals are needed to tag electrons.

C) Pions at 10 GeV with a range of intensity from roughly 10HZ total over 5 inch square to a few hundred Hz over an area of a square inch. Momentum spread should be less than +- 20%. Running will be with material in front of an RPC for hadronic showers. Two days for each of three setups.

D) Pions at 30 GeV with a range of intensity from roughly 10HZ total over 5 inch square to a few hundred Hz over an area of a square inch. Momentum spread should be less than +- 20%. We will run with material in front of an RPC for hadronic showers. Two days for each of three setups. E) Electrons of 8 GeV, with beam intensity from 10 to 100 / cm^2 / spill. Tagging of electrons will be done by the two beamline Cherenkov counters. Running with showering material (lead and aluminum) and with no showering material in the beam. At least two days total will be required for this run, but distributed over the running times for all three electronics systems.

2.2.2

2.2.3 BEAM SHARING: Most likely we could run parasitically downstream of some other test during most of our setup and debugging. Also, because of limited manpower we cannot run continuously. We can alternate with other users

2.2.4 RUNNING TIME: Beam time is requested in beam requests A- E above. We would be constrained in time by not having a lot of manpower. We propose that the setup could be done in steps over a few weeks, and the running could be various short runs of hours to a couple of days as beam and manpower were available. We request to remain in the beam area until March, but with our material moved out of the actual beam when necessary for other users.

SETUP

2.3.1 Our setup consists of a stand with one to five RPC's and removable material to generate hadronic showers as in a calorimeter. The detector part would be less than 1 cubic foot in the beamline (above some table), but we need room for iron plates for shower development in front of our detector. The parts can be carried in by hand. (the total weight might be a few hundred pounds).

2.3.2 A table in the beamline to support the detector, and the iron plates for shower development. We request to use the existing motion table in MT6-B which is at least 7 inches below the beam and also would allow our showering material to be rolled to the side of the beam easily. We expect to have less than 600 pounds of material in less than 1 meter length.
2.3.3 Electric power for electronics both in the beam area and in the counting house.
2.3.4 Ethernet connection for data transmission offsite from a computer which will use ftp to transfer image files to a processor in VME. If there is a firewall issue, the data can be transferred in sequential transfers between networks.
2.3.5 We require crate with either , a network connection, ing RPC readout software for a at Fermilab
2.3.6 Access to the beam area periodically for installation and cabling and installing gas lines.2.3.7 will supply at least one DAQ computer.
2.3.8 We need discussions on whether to use the MTBF how to combine data from 3 different readout systems.
2.4 SCHEDULE

WE PROPOSE TO DO THIS TEST IN LATE 2005 AND EARLY 2006. **III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB**

([] denotes replacement cost of existing hardware.)

| | | |
|---|---|---|
| 3.1 | Resistive plate chambers, 8 inch square, more than 3 units ($2k each) | [$10k] |
| 3.1.1 | Gas (non-flamable, 5%Isobutane and ½& SF6 remainder R134 Freon | [ 3] |
| 3.1.2 | High Voltage supplies ( Univ of Iowa) | [15] |
| 3.1.3 | Pulse generator w/ adj rate | [ 1] |
| 3.1.4 | 2PC's,monitors | [6] |
| 3.1.5 | Soldering iron | [ 1] |
| 3.1.6 | Asst. lemo cables, voltmeters, tools, toolbox | [ 1] |
| 3.2.7 | Digital scope | [10] |
| | Total existing items | [$47K] |

## IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

([] Denotes replacement cost of existing hardware.)

**4.1 Fermilab Accelerator Division:**

4.1.1 Use of MTest beam.
4.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.
4.1.3 A scaler or beam counter signal should be made available in the counting house.
4.1.4 Reasonable access to our equipment in the test beam.

4.1.5 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR).

4.1.6 Position and focus of the beam on the experimental devices under test will be under control of MCR. Control of secondary devices that provide these functions may be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

4.1.7 The integrated effect of running this and other SY120 beams will not reduce the antiproton stacking rate or protons on target for neutrino production by more than 5% globally, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.

**4.2 Fermilab Particle Physics Division**

4.2.1 The test-beam efforts in this MOU will make use of the Meson Test Beam Facility. Requirements for the beam and user facilities are given in Section 2. The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer. [0.5 person weeks]

**4.3 Fermilab Computing Division**

4.3.1 Ethernet and printers should be available in the counting house.

4.3.2 Connection to beams control console and remote logging (ACNET) should be made available in the counting house.

4.3.3 Assistance with setup of VME system. [0.5 person weeks]

4.3.4 See Appendix II for summary of PREP equipment pool needs.

**4.4 Fermilab ES&H Section**

4.4.1 Assistance with safety reviews.

4.4.2 Loan of radioactive source (preferably $Sr^{90}$, 0.1mCi) for the duration of the test beam.

## V. SUMMARY OF COSTS

| **Source of Funds [$K]** | **Equipment** | **Operating** | **Personnel** (person-weeks) |
|---|---|---|---|
| Particle Physics Division | $0.0K | $0K | 0.5 |
| Beams Division | 0 | 0 | 0 |
| Computing Division | 0 | 0 | 0.5 |
| | | | |
| Totals Fermilab | $0.0K | 0 | 1.0 |
| Totals Non-Fermilab | [$47K] | | |

## VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the RPC Detector Research Group Spokesperson and procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (PFX) (http://www.fnal.gov/directorate/documents/). The Physicist in charge agrees to those responsibilities and to follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. This includes creating a Partial Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The RPC Detector Research Group Spokesperson will follow those procedures in a timely manner, as well as any other requirements put forth by the division's safety officer.

6.3 The RPC Detector Test Beam Spokesperson will ensure that at least one person is present at the Meson Test Beam Facility whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

6.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

6.5 All items in the Fermilab Policy on Computing will be followed by experimenters. (http://security.fnal.gov/Policies/Fermilab%20Policy%20on%20Computing.htm)

6.6 The RPC Detector Research Group Spokesperson will undertake to ensure that no PREP and computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Division management. They also undertake to ensure that no modifications of PREP equipment take place without the knowledge and consent of the Computing Division management.

6.7 Each institution will be responsible for maintaining and repairing both the electronics and the computing hardware supplied by them for the experiment. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

6.8 If the experiment brings to Fermilab on-line data acquisition or data communications equipment to be integrated with Fermilab owned equipment, early consultation with the Computing Division is advised.

6.9 At the completion of the experiment:

6.9.1 The RPC Detector Research Group Spokesperson is responsible for the return of all PREP equipment, Computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the RPC Detector Research Group Spokesperson will be required to furnish, in writing, an explanation for any non-return.

6.9.2 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ES&H requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters.

6.9.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied

6.9.4 An experimenter will be available to report on the test beam effort at a Fermilab All Experimenters Meeting.

**SIGNATURES:**

________________________________ / / 2005
David Underwood, Argonne National Laboratory

________________________________ / / 2005
Jim Strait, Particle Physics Division

________________________________ / / 2005
Roger Dixon, Accelerator Division

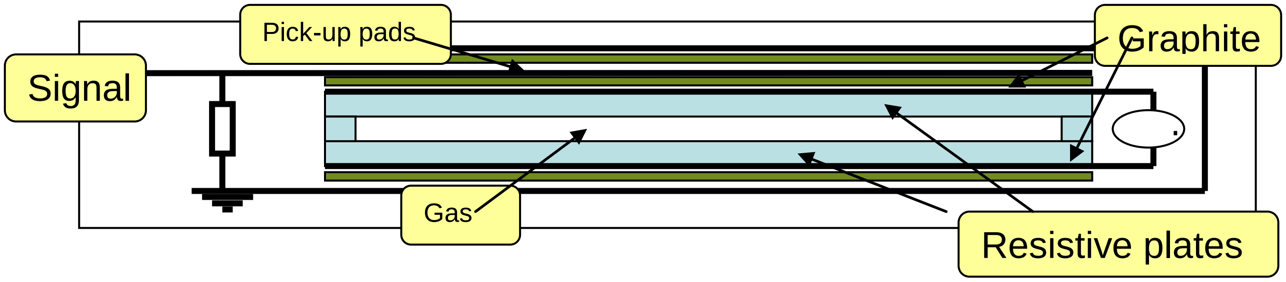
________________________________ / / 2005
Robert Tschirhart, Computing Division

________________________________ / / 2005
William Griffing, ES&H Section

________________________________ / /2005
Hugh Montgomery, Associate Director, Fermilab

________________________________ / /2005
Steven Holmes, Associate Director, Fermilab

**APPENDIX I – RPC DETECTOR PROPERTIES**




see: http://www.hep.anl.gov/repond/LCD.html

## APPENDIX II – RPC DETECTOR BEAM TEST – EQUIPMENT NEEDS

Equipment Pool and PPD items needed for Fermilab test beam, on the first day of setup:

| Quantity | Description |
|---|---|
| PPD MTest facility: | |
| 2 | Nim crates, with cooling fans |
| 1 | Camac crate, powered |
| 1 | analogue or digital oscilliscope |
| 8 | SHV cables from detector to Power supplies in counting house |
| 4 | RG58 / BNC cables from scintillation ctrs. To counting house |
| 50 | Lemo cables, various lengths |
| 6 | Gas lines (3 into area, 3 out) |
| 3 | Gas flow meters with flow control |
| 3 | Gas bubblers |
| PREP: | |
| 1 | VME crate, 6U, with power supply |
| 1 | Motorola VME controller, such as MVME 162-22 or similar |
| 1 | Ethernet Interface to VME controller |
| 1 | VME ADC for phototube signals, more than one channel, at least 12 bit |
| 1 | Camac ADC for phototube signals, more than one channel, at least 12 bit |
| 1 | VME Latch (either NIM/Lemo input or additionally a level converter) |
| 1 | Camac latch (either NIM/Lemo input or additionally a level converter) |
| 1 | Camac Lecroy 2371 |
| 4 | Power supplies, + and – 5 V (one pair at VME, one pair at detector) |
| 3 | NIM BERTAN HV supply 1792X +/- 10 KV or equivalent |
| 5 | NIM Octal descriminators Lecroy 623 |
| 4 | NIM logic fan in/out Lecroy 429a |
| 2 | Quad Scaler and Preset Counter CAEN N145 or equivalent |
| 2 | NIM gate generators Philips 794 or similar |
| 4 | NIM Tri- coincidence logic Lecroy 465 or similar |
| 3 | NIM quad-coin. logic Lecroy 622 or similar |
| 1 | TTL ←→ Nim level adapter Lecroy 688AL or similar |
| 2 | HV supplies for 4 Scintillation counters utilizing PMTs more than 1 mA ea. |

**APPENDIX III - Hazard Identification Checklist**

Items for which there is anticipated need have been checked

| | **Cryogenics** | | **Electrical Equipment** | | **Hazardous/Toxic Materials** |
|---|---|---|---|---|---|
| | Beam line magnets | | Cryo/Electrical devices | | List hazardous/toxic materials |
| | Analysis magnets | | capacitor banks | | planned for use in a beam line or experimental enclosure: |
| | Target | X | high voltage | | |
| | Bubble chamber | X | exposed equipment over 50 V | | |
| | **Pressure Vessels** | | **Flammable Gases or Liquids** | | |
| | inside diameter | Type: | Isobutane (5% of a non-flammable mixture) | | |
| | operating pressure | Flow rate: | | | |
| | window material | Capacity: | | | |
| | window thickness | | **Radioactive Sources** | | |
| | **Vacuum Vessels** | | permanent installation | | **Target Materials** |
| | inside diameter | X | temporary use | | Beryllium (Be) |
| | operating pressure | Type: | **Sr90** | | Lithium (Li) |
| | window material | Strength: | **5 mCi** | | Mercury (Hg) |
| | window thickness | | **Hazardous Chemicals** | | Lead (Pb) |
| | **Lasers** | | Cyanide plating materials | | Tungsten (W) |
| | Permanent installation | | Scintillation Oil | | Uranium (U) |
| | Temporary installation | | PCBs | X | Other : **Si, C (diamond)** |
| | Calibration | | Methane | | **Mechanical Structures** |
| | Alignment | | TMAE | | Lifting devices |
| type: | | | TEA | X | Motion controllers |
| Wattage: | | | photographic developers | | scaffolding/elevated platforms |
| class: | | | Other: Activated Water? | | Others |